

## 3.2 Near-Facility Environmental Monitoring

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Several types of environmental media are sampled, and various radiological measurements are taken near nuclear facilities to monitor the effectiveness of effluent treatment and control practices and contamination control in waste management and restoration activities. These include air, surface and spring waters, surface contamination, soil and vegetation, investigative sampling (which can include wildlife), and external radiation. Sampling and analysis information and analytical results for 1997 for each of these are summarized below. Additional data and more detailed information may be found in *Hanford Site Near-Facility Environmental Monitoring Annual Report, Calendar Year 1997* (HNF-EP-0573-6).

### 3.2.1 Near-Facility Environmental Monitoring

Near-facility (near-field) environmental monitoring is defined as routine monitoring near facilities that have potential to discharge, or have discharged, stored, or disposed of radioactive or hazardous contaminants. Monitoring locations are associated with nuclear facilities, such as the Plutonium-Uranium Extraction Plant and N Reactor, and waste storage or disposal facilities, such as burial grounds, tank farms, ponds, cribs, trenches, and ditches.

Much of the monitoring program consists of collecting and analyzing environmental samples and methodically surveying areas near facilities releasing effluents and waste streams. The program also evaluates acquired analytical data, determines the effectiveness of facility effluent monitoring and controls, measures the adequacy of containment at waste disposal units, and detects and monitors unusual conditions. The program implements applicable portions of DOE Orders 5400.1, 5400.5, 5484.1, and 5820.2A; WAC 246-247; and 10 CFR 835 and 40 CFR 61.

Routine monitoring activities include sampling and monitoring ambient air, water from surface-water disposal units, external radiation dose rate, soil, sediment, vegetation, and animals. Some of the parameters typically monitored are pH, radionuclide concentrations, radiation exposure rate levels, and concentrations of selected hazardous chemicals. Samples are collected from known or expected effluent pathways. These pathways are generally downwind of potential or actual airborne releases and downgradient of liquid discharges. The routine activities of near-facility monitoring in 1997 are summarized in Table 3.2.1, which shows the type, quantity, and general location of samples collected.

Waste disposal sites and the terrain surrounding them are surveyed to detect and characterize radioactive surface contamination. Routine survey locations include cribs, trenches, retention basin perimeters, pond perimeters, ditch banks, solid waste disposal sites (e.g., burial grounds, trenches), unplanned release sites, tank farm perimeters, stabilized waste disposal sites, roads, and firebreaks in and around the site operational areas.

### 3.2.2 Air Monitoring

Near-facility air sampling is performed to monitor the effectiveness of waste management and effluent treatment and controls in reducing effluents and emissions; these systems also monitor diffuse source emissions.

#### 3.2.2.1 Collection of Air Samples and Analytes of Interest

Radioactivity in air was sampled by a network of continuously operating samplers at 62 locations near nuclear facilities: 3 at the 100 B,C Area, 4 at the 100-D,DR Area, 4 the 100-K Area, 4 in the 100-N Area, 37 in the 200 Areas, 3 at the Environmental Restoration Disposal

**Table 3.2.1.** Near-Facility Routine Environmental Samples and Locations, 1997

Sample Type	Total Number of Sample Locations	Operational Area							
		100-B,C	100-D,DR	100-K	100-N	ERDF <sup>(a)</sup>	200/ 600	300/ 400	TWRS <sup>(b)</sup>
Air	62	3	4	4	4	3	38 <sup>(c)</sup>	6	0
Water	14	0	0	0	12	0	2	0	0
External radiation	165	4	5	11	48 <sup>(d)</sup>	3	63	21	10
Soil	80	0	2	0	7	1	55	15	0
Vegetation	66	0	0	0	10	0	41	15	0

(a) Environmental Restoration Disposal Facility.

(b) Tank Waste Remediation System.

(c) Includes one station located at the Wye Barricade.

(d) Twenty-two thermoluminescent dosimeters and 26 survey points.

Facility, 3 at the 300-FF-1 Operable Unit (north of the 300 Area), 2 at the 3732 Building (300 Area), 1 near the 300 Area Treated Effluent Disposal Facility, and 1 collocated with samplers operated by the Pacific Northwest National Laboratory and the Washington State Department of Health at the Wye Barricade in the 600 Area. To avoid duplication of sampling, the Near-Facility Environmental Monitoring Program relied on analytical results obtained from existing Pacific Northwest National Laboratory air samplers in the 300 and 400 Areas. Air samplers were located primarily at or near (within approximately 500 m [1,500 ft]) sites and/or facilities having the potential for, or history of, environmental releases, with an emphasis on the prevailing downwind direction.

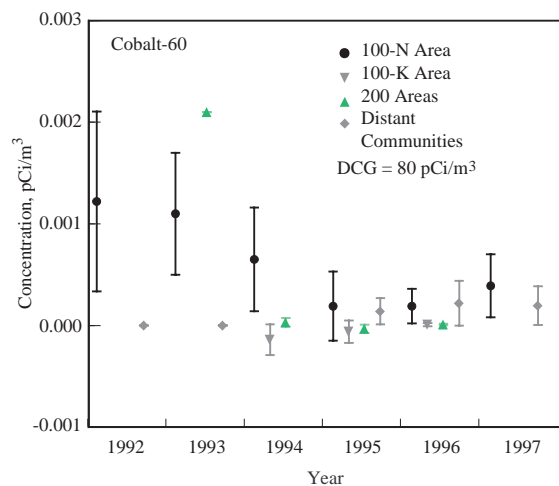
Samples were collected according to a schedule established before the monitoring year. Airborne particles were sampled at each station by drawing air through a glass-fiber filter. The filters were collected biweekly, field surveyed for gross radioactivity, held for at least 7 days, and then analyzed for gross alpha and beta activity. The 7-day holding period was necessary to allow for the decay of naturally occurring radionuclides that would otherwise obscure detection of longer-lived radionuclides associated with emissions from nuclear facilities. The gross radioactivity measurements were used to indicate changes in trends in the near-facility environment.

For most radionuclides, the amount of radioactive material collected on a single filter during a 2-week sampling period was too small to be measured accurately. The accuracy of the sample analysis was increased by compositing the samples into biannual samples for each location.

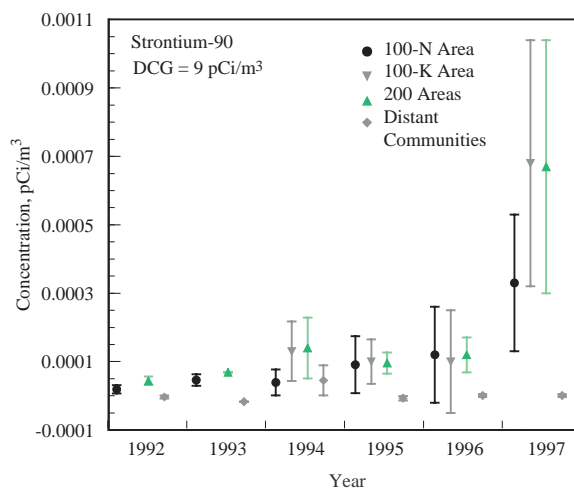
Each composite sample was analyzed for strontium-90, uranium-234, uranium-235, uranium-238, plutonium-238, plutonium-239,240, and gamma-emitting radionuclides (e.g., cobalt-60, cesium-137). Samples from the 100-K Area were also analyzed for americium-241 and plutonium-241.

### 3.2.2.2 Radiological Results for Air Samples

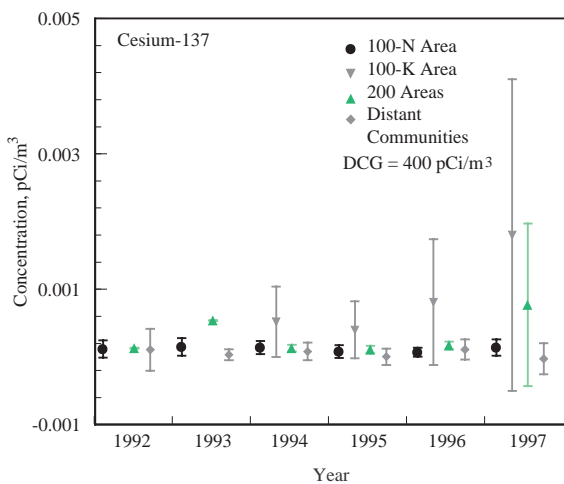
Of the radionuclide analyses performed, strontium-90, cesium-137, plutonium-239,240, and uranium were consistently detected in the 100-K, 100-N, and 200 Areas. Cobalt-60 was consistently detected in the 100-N Area. Air concentrations for these radionuclides were elevated near facilities compared to the concentrations measured offsite. Figure 3.2.1 shows average values for 1997 and the preceding 5 years for selected radionuclides compared to DOE derived concentration guides (DOE Order 5400.5) and the background air concentration as measured by the Pacific Northwest National Laboratory in distant communities. The DOE derived concentration guides are reference values that are used as indexes of performance (Appendix C, Table C.5). The data indicate a large degree of variability. In general, air samples collected from air samplers located at or directly adjacent to nuclear facilities had higher concentrations than did those samples collected farther away. The data also show that concentrations of certain radionuclides were higher within different operational areas. Generally, the predominant radionuclides are activation products (i.e., gamma emitters) in the 100 Areas and fission products in the 200 Areas.



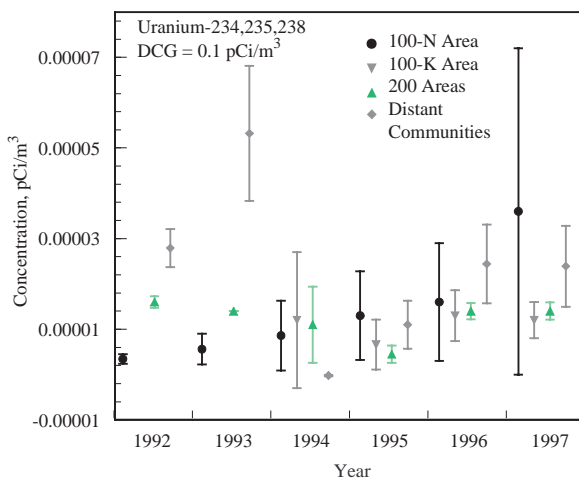
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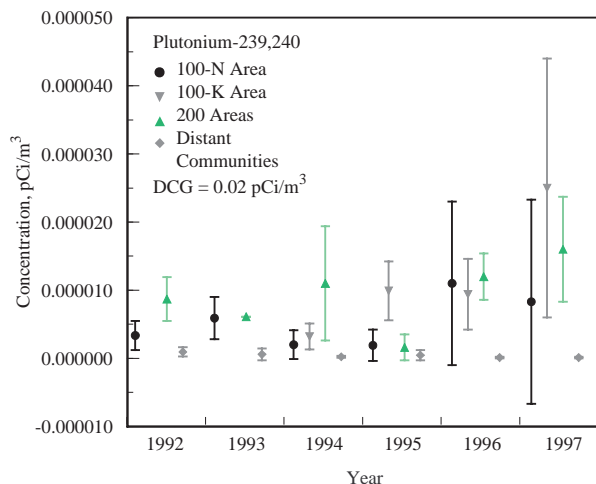
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**Figure 3.2.1.** Average Concentrations ( $\pm 2$  standard error of the mean) of Selected Radionuclides in Near-Facility Air Samples Compared to Those in Distant Communities, 1992 Through 1997. As a result of figure scale, some uncertainties (error bars) are concealed by point symbol. Cobalt-60 was not detected in the 100-K and 200 Areas in 1997.

**100-B,C Area.** Near-facility air sampling was conducted at the 100-B,C remediation site through a network of three continuous air samplers. Monitoring began in July 1996, and the analytical results indicated that radionuclide concentrations were much less than the DOE derived concentration guides and only slightly greater than levels measured offsite.

**100-D,DR Area.** Near-facility air sampling was conducted at the 100-D,DR remediation site through a network of four continuous air samplers. Monitoring began in November 1996, and the analytical results indicated that radionuclide concentrations were much less than the DOE derived concentration guides and only slightly greater than levels measured offsite.

**100-K Area.** Analytical results from four 100-K Area ambient air samplers show quantities of strontium-90, cesium-137, plutonium-239,240, plutonium-241, and americium-241 above detection levels. These levels were much less than the DOE derived concentration guides; however, they were greater than levels measured offsite. Facility emissions in 1997 did not differ significantly from those in 1996, and radionuclide concentrations seen in the ambient air samples were near detection limits.

**100-N Area.** Analytical results from four ambient air samplers in the 100-N Area show quantities of strontium-90, uranium-234, and uranium-235 above detection levels. Radionuclide concentrations were much less than the DOE derived concentration guides; however, they were slightly greater than levels measured offsite.

**200 Areas.** Analytical results from 37 ambient air samplers in the 200 Areas were at or near Hanford Site background concentrations for most radionuclides as a result of facility shutdowns, better effluent controls, and improved waste management practices. Although levels were much less than the DOE derived concentration guides, they were greater than those measured offsite. Levels of strontium-90 and plutonium-239,240 were comparable to those measured in the 100-N Area.

**Environmental Restoration Disposal Facility.** Near-facility air sampling was conducted at the Environmental Restoration Disposal Facility remediation site through a network of continuous air samplers. This network utilized two existing Hanford Site monitors for upwind monitoring and was supplemented by three project-specific air monitors that provided downwind monitoring. The analytical results indicate that radionuclide concentrations in

1997 were much less than the DOE derived concentration guides and only slightly greater than levels measured offsite.

**300-FF-1 Operable Unit.** Near-facility air sampling was conducted at the 300-FF-1 Operable Unit remediation site in the 300 Area through a network of continuous air samplers. This network utilized one existing Hanford Site monitor for upwind monitoring and three project-specific downwind air monitors. Additional downwind monitoring is provided by existing Pacific Northwest National Laboratory air samplers. Monitoring began in May 1997, and the analytical results indicated that radionuclide concentrations were much less than the DOE derived concentration guides and only slightly greater than levels measured offsite.

**3732 Building.** Near-facility air sampling was conducted during the demolition of the 3732 Building in the 300 Area through the use of two continuous air samplers. These samplers provided downwind monitoring during a 2-week demolition period in September 1997, and the analytical results indicated that radionuclide concentrations were much less than the DOE derived concentration guides and only slightly greater than levels measured offsite.

### 3.2.3 Surface-Water Disposal Units and 100-N Riverbank Springs Monitoring

Surface-water disposal units (open ponds and ditches), used by the operating facilities, and springs along the 100-N Area Columbia River shoreline are monitored to assess the effectiveness of effluent and contamination controls. Two surface-water disposal units in the 200-East Area that received potentially radiologically contaminated effluent were sampled during 1997: the 200-East Area Powerhouse Ditch and the 216-B-3C Expansion Pond.

#### 3.2.3.1 Collection of Surface-Water and Riverbank Springs Samples and Analytes of Interest

Samples collected from surface-water disposal units in the 200-East Area included water, sediment, and aquatic vegetation. Only water samples were taken at riverbank springs. The sampling methods are discussed in detail in WMNW-CM-4. Samples were also collected from a

small discharge pond in the 400 Area by Pacific Northwest National Laboratory. Analytical results for the 400 Area samples are reported in Section 4.2, "Surface Water and Sediment Surveillance," and are not discussed here.

All radiological analyses were performed onsite at the Waste Sampling and Characterization Facility near the 200-West Area in 1997. Radiological analyses of 200-East Area water samples included uranium, tritium, strontium-90, plutonium-238, plutonium-239,240, and gamma-emitting radionuclides. Radiological analyses of sediment and aquatic vegetation samples were performed for uranium, strontium-90, plutonium-239,240, and gamma-emitting radionuclides. Analyses for riverbank springs included tritium, strontium-90, and gamma-emitting radionuclides. Nonradiological analyses were performed for pH, temperature, and nitrates. Analytes of

interest were selected based on their presence in effluent discharges and their importance in verifying effluent control and determining compliance with applicable effluent discharge standards.

### 3.2.3.2 Radiological Results for Surface-Water Disposal Units

Radiological results for liquid samples from the 200-East Area surface-water disposal units are summarized in Table 3.2.2. In all cases, radionuclide concentrations were less than the DOE derived concentration guides.

Radiological results for aquatic vegetation and sediment samples taken from the 200-East Area surface-water disposal units are summarized in Tables 3.2.3 and 3.2.4,

**Table 3.2.2.** Radiological Results (pCi/L) for Liquid Samples from Surface-Water Disposal Units, 200 Areas, 1997

Sample Location	No. of Samples		<sup>3</sup> H <sup>(a)</sup>	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>238</sup> Pu	<sup>239,240</sup> Pu	Total U
216-B-3C Expansion Pond (200-East Area)	9	Mean	ND <sup>(b)</sup>	ND	ND	ND	ND	0.65
		Maximum	ND	ND	ND	ND	ND	0.99
200-East Area Powerhouse Ditch	12	Mean	ND	0.3	ND	0.0064	0.014	0.47
		Maximum	ND	3.0	ND	0.036	0.073	0.58
		DCG <sup>(c)</sup>	2,000,000	1,000	3,000	40	30	500 <sup>(d)</sup>

(a) The detection limit for tritium was between 170 and 220 pCi/L. Samples were collected quarterly.

(b) ND = Not detected.

(c) DCG = DOE derived concentration guide (DOE Order 5400.5).

(d) Using uranium-234 as the most limiting DCG.

**Table 3.2.3.** Radiological Results (pCi/g, dry wt.) for Aquatic Vegetation Samples from Surface-Water Disposal Units, 200 Areas, 1997

Sample Location	No. of Samples	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>239,240</sup> Pu	<sup>234</sup> U	<sup>235</sup> U	<sup>238</sup> U
216-B-3C Expansion Pond (200-East Area)	1	0.34	0.38	0.0038	0.017	0.008	0.0085
200-East Area Powerhouse Ditch	1	0.37	ND <sup>(a)</sup>	ND	0.013	0.0099	0.0078

(a) ND = Not detected.

**Table 3.2.4.** Radiological Results (pCi/g, dry wt.) for Sediment Samples from Surface-Water Disposal Units, 200 Areas, 1997

Sample Location	No. of Samples	<sup>90</sup> Sr	<sup>137</sup> Cs	<sup>239,249</sup> Pu	<sup>234</sup> U	<sup>235</sup> U	<sup>238</sup> U
216-B-3C Expansion Pond (200-East Area)	1	0.71	11	0.20	0.33	0.06	0.29
200-East Area Powerhouse Ditch	1	ND <sup>(a)</sup>	ND	0.0049	0.38	0.022	0.39

(a) ND = Not detected.

respectively. Although there were some levels above background in both aquatic vegetation and sediment, all results were much less than the standards cited in the *Hanford Site Radiological Control Manual* (HSRCM-1, Rev. 2).

### 3.2.3.3 Radiological Results for 100-N Riverbank Springs

In the past, radioactive effluent streams sent to the 1301-N and 1325-N Liquid Waste Disposal Facilities in the 100-N Area contributed to the release of radionuclides to the Columbia River through their migration with the groundwater. Radionuclides from these facilities enter the Columbia River along the riverbank region sometimes called N Springs. The amount of radionuclides entering the river at these springs is calculated based on analysis of monthly samples collected from monitoring well 199-N-46 located near the shoreline. A more detailed discussion of the release calculations may be found in HNF-EP-0527-07.

Groundwater springs along the 100-N Area shoreline are sampled annually to verify that the reported radionuclide releases to the Columbia River are conservative (i.e., not underreported). To verify releases, conservatively high radionuclide concentrations in samples collected from well 199-N-46 are multiplied by the estimated groundwater discharge into the river. The groundwater flow rate at these springs was estimated using a computer model developed by Gilmore et al. (PNL-8057). The estimated groundwater flow rate used to calculate 1997 releases from the springs was 43 L/min (11 gal/min). The results of the springs samples can then be compared to the concentrations measured in well 199-N-46 to ensure that concentrations in the well reflect the highest concentrations of radionuclides in the groundwater.

In 1997, the concentrations of tritium and strontium-90 detected in samples from riverbank springs were highest in springs nearest well 199-N-46. The highest cobalt-60 concentrations, though very low, were from a location approximately 200 m (656 ft) down river (northeast) of well 199-N-46. All of the riverbank springs concentrations were lower than those measured in the well. The data from riverbank springs sampling are summarized in Table 3.2.5.

### 3.2.3.4 Nonradiological Results for Surface-Water Disposal Units

Nonradiological results for water samples taken from the 200-East Area surface-water disposal units are summarized in Table 3.2.6. The results for pH were well within the standard of 2.0 to 12.5 for liquid effluent discharges based on the limits given in the Resource Conservation and Recovery Act. The analytical results for nitrates were all less than the 45-mg/L state and federal drinking water standard for public water supplies (WAC 246-249, 40 CFR 141).

**Table 3.2.5.** Concentration (pCi/L) of Radionuclides in 100-N Area Columbia River Shoreline Springs, 1997

Radionuclide	Facility Effluent Monitoring Well 199-N-46	Shoreline Springs		DCG <sup>(a)</sup>
		Maximum	Average	
Tritium	16,000	3,000	210	2,000,000
Cobalt-60	<2.2	9.1	1.3	5,000
Strontium-90	11,000	3,200	345	1,000

(a) DCG = DOE derived concentration guide (DOE Order 5400.5).

**Table 3.2.6.** Nonradiological Results for Water Samples from Surface-Water Disposal Units, 200 Areas, 1997

Sample Location	pH				Nitrate (NO <sub>3</sub> ), mg/L		
	No. of Samples	Mean	Maximum	Minimum	No. of Samples	Mean	Maximum
216-B-3C Expansion Pond (200-East Area)	36	8.4	8.9	7.9	3	0.22	0.37
200-East Area Powerhouse Ditch	52	8.8	9.3	8.0	4	0.17	0.24

### 3.2.4 Radiological Surveys

Radiological surveys are used to monitor and detect contamination on the Hanford Site. The two main types of posted radiologically controlled areas are underground radioactive materials and contamination areas. Controlled areas include contamination areas, soil contamination areas, and high contamination areas.

Underground radioactive material areas are posted areas that have contamination contained below the soil surface. These areas are typically “stabilized” cribs, burial grounds, covered ponds, trenches, and ditches. Barriers over the contamination sources are used to inhibit radionuclide transport to the surface environs. These areas are surveyed at least annually to document the current radiological status.

Contamination/soil contamination areas may or may not be associated with an underground radioactive material structure. A breach in the barrier of an underground radioactive materials area may result in the growth of contaminated vegetation. Insects or animals may burrow into an underground radioactive materials area and bring contamination to the surface. Vent pipes or risers from an underground structure may be a source of speck contamination. Fallout from stacks or unplanned releases from previously operating facilities may cause an area of contamination that is not related to a subsurface structure. All types of contamination areas may be susceptible to contamination migration. All known contamination areas are surveyed at least annually to document the current radiological status.

In 1997, the Hanford Site had approximately 3,990 ha (9,859 acres) of posted outdoor contamination areas and 614 ha (1,517 acres) of posted underground radioactive materials areas not including active facilities. The number

of hectares (acres) of contamination areas is approximately six times larger than the underground radioactive materials areas. This is primarily because of the BC Cribs controlled area located south of the 200-East Area. This area was initially posted as a radiologically controlled area in 1958 because of widespread speck contamination and encompassed approximately 1,000 ha (2,500 acres). Additional investigative surveys were conducted adjacent to the BC Cribs area in 1996, and the area was enlarged to 3,832 ha (9,469 acres). Table 3.2.7 lists the contamination areas and underground radioactive material areas in 1997. A global positioning system was used in 1996 and 1997 to measure the surface contamination areas more accurately than in previous years. Area measurements are entered into the Hanford Geographical Information System, a computer database maintained by the environmental restoration contractor.

The posted contamination areas vary in number and size between years because of an ongoing effort to clean, stabilize, and remediate areas of known contamination. During this time, new areas of contamination are also being identified. Table 3.2.8 indicates the changes resulting from stabilization activities during 1997. Approximately 13.4 ha (33.1 acres) were reclassified from contamination/soil contamination areas to underground radioactive materials areas, 1.9 ha (4.7 acres) were posted as soil contamination areas, and 5.2 ha (12.8 acres) were changed from no posting to underground radioactive materials areas. Newly identified areas may have resulted from contaminant migration or an increased effort to investigate outdoor areas for radiological contamination. Vehicles equipped with radiation detection devices and an ultrasonic ranging and data system have identified areas of contamination that were previously undetected.

It was estimated that the external dose rate at 80% of the identified outdoor contamination areas was less than 1 mrem/h, though direct dose rate readings from isolated

**Table 3.2.7.** Outdoor Contamination Status, 1997

Area	Contamination Areas, <sup>(a)</sup> ha (acres)		Underground Radioactive Material Areas, <sup>(b)</sup> ha (acres)	
100-B,C	8	(20)	39	(96)
100-D,DR	0.1	(0.2)	39	(96)
100-F	0.7	(1.7)	33	(82)
100-H	0.1	(0.2)	14	(35)
100-K	9	(22)	62	(153)
100-N	29	(73)	0.2	(0.5)
200-East <sup>(c)</sup>	62	(153)	139	(343)
200-West <sup>(c)</sup>	30	(74)	221	(546)
300	19	(47)	13	(32)
400		0		0
600 <sup>(d)</sup>	3,832	(9,469)	54	(133)
<b>Totals</b>	<b>3,990</b>	<b>(9,859)</b>	<b>614</b>	<b>(1,517)</b>

- (a) Includes areas posted as contamination/soil contamination or as radiologically controlled and areas that had both underground and contamination/soil contamination.
- (b) Includes areas with only underground contamination. Does not include areas that had contamination/soil contamination as well as underground radioactive material.
- (c) Includes tank farms.
- (d) Includes BC Cribs controlled area, waste disposal facilities outside the 200-East Area boundary that received waste from 200-East Area facilities (e.g., 216-A-25, 216-B-3), and waste disposal facilities outside the 200-West Area boundary that received waste from 200-West Area facilities (e.g., 216-S-19, 216-U-11). The first cell of the Environmental Restoration Disposal Facility was added during 1997.

**Table 3.2.8.** Zone Status Change of Posted Contamination Areas, 1997 (changes from stabilization activities or newly discovered sites)

Area	Zone Change	Area, ha (acres)	
100	CA to URM <sup>(a)</sup>	1.7	(4.2)
200-East	CA to URM	5.6	(13.8)
200-West	CA to URM	4.1	(10.1)
300	CA to URM	0	
400	CA to URM	0	
600	CA to URM	2.0	(5.0)
	NP to CA	1.9	(4.7)
	NP to URM	5.2	(12.8)

- (a) CA = Contamination/soil contamination area.  
 URM = Underground radioactive material area.  
 NP = No posting.

radioactive specks (a diameter less than 0.6 cm [0.25 in.]) could have been considerably higher. Contamination levels of this magnitude did not significantly add to dose rates for the public or Hanford Site workers in 1997.

### 3.2.5 Soil and Vegetation Sampling from Operational Areas

Soil and vegetation samples were collected on or adjacent to waste disposal units and from locations downwind and near or within the boundaries of the operating facilities. Samples were collected to detect potential migration and deposition of facility effluents. Special samples were also taken where physical or biological transport problems were identified. Migration can occur as the result of resuspension from radioactively contaminated surface areas, absorption of radionuclides by the roots of vegetation growing on or near underground and surface-water disposal units, or by waste site intrusion by animals.

In 1994, routine annual soil and vegetation sampling was eliminated in the 100 Areas, except for the 100-N Area. Historical data indicated that the previously monitored 100 Area sites exhibited no signs of contamination migration trends, and continued monitoring would not be cost effective. At the 100-N Area, the sites that continue to be used are those nearest the liquid waste disposal facilities. Soil sampling in the 200 Areas was modified in 1994 to be more cost effective. Fifty-four soil samples are collected at alternating locations each year.

In accordance with state regulations, soil samples were collected at the 100-D Area and the Environmental Restoration Disposal Facility remediation projects managed and operated by the environmental restoration contractor to determine the effectiveness of contamination controls. The sample collected at the Environmental Restoration Disposal Facility site in 1997 represents the initial (baseline) sample to be used for future comparison. At the 100-D Area, the 1997 sample was a follow-up to the 1996 sample collected from the same location.

#### 3.2.5.1 Collection of Soil and Vegetation Samples and Analytes of Interest

The sampling methods and locations used are discussed in detail in WMNW-CM-4. Radiological analyses of soil

and vegetation samples included strontium-90, plutonium-239,240, uranium, and gamma-emitting radionuclides.

**Radiological Results for Soil Samples.** Of the radionuclide analyses performed, cobalt-60, strontium-90, cesium-137, plutonium-239,240, and uranium were consistently detectable. Soil concentrations for these radionuclides were elevated near and within facility boundaries when compared to concentrations measured offsite in 1997. Figure 3.2.2 shows average soil values for 1997 and the preceding 5 years. The concentrations show a large degree of variability. In general, concentrations in samples collected on or directly adjacent to waste disposal facilities were higher than concentrations in samples collected farther away and significantly higher than historical concentrations measured offsite. The data also show, as expected, that concentrations of certain radionuclides were higher within different operational areas when compared to concentrations measured in distant communities. Generally, the predominant radionuclides were activation and fission products in the 100-N Area, fission products in the 200 Areas, and uranium in the 300/400 Areas.

**100-D Area and Environmental Restoration Disposal Facility.** The sampling results indicate that, at both sites, radionuclide concentrations were comparable to those measured offsite. At the 100-D Area, the 1997 results were higher than the 1996 results, though within the historical ranges observed in soil samples collected in the 100 Areas from 1981 through 1990. The apparent increase in soil sample concentrations does not correlate with the results observed in the nearby air samplers and most likely is due to the relatively small data set being used for comparison. These samples will continue to be collected annually, and the results carefully monitored to determine any trends.

**100-N Area.** The analytical results from soil samples collected in the 100-N Area in 1997 generally exhibit concentrations at or near historical onsite levels. However, concentrations of cobalt-60, strontium-90, plutonium-238, and plutonium-239,240 were noticeably elevated at a sampling location near the retired 1301-N Liquid Waste Disposal Facility. Additionally, contamination levels were greater than those measured offsite, and the concentrations of cobalt-60, strontium-90, and plutonium-239,240 were greater than those measured in the 200 and 300/400 Areas. The cobalt-60, strontium-90, and plutonium-239,240 concentrations in the 100-N Area soils resulted from past discharges to waste disposal structures, primarily the 1301-N Liquid Waste Disposal Facility.

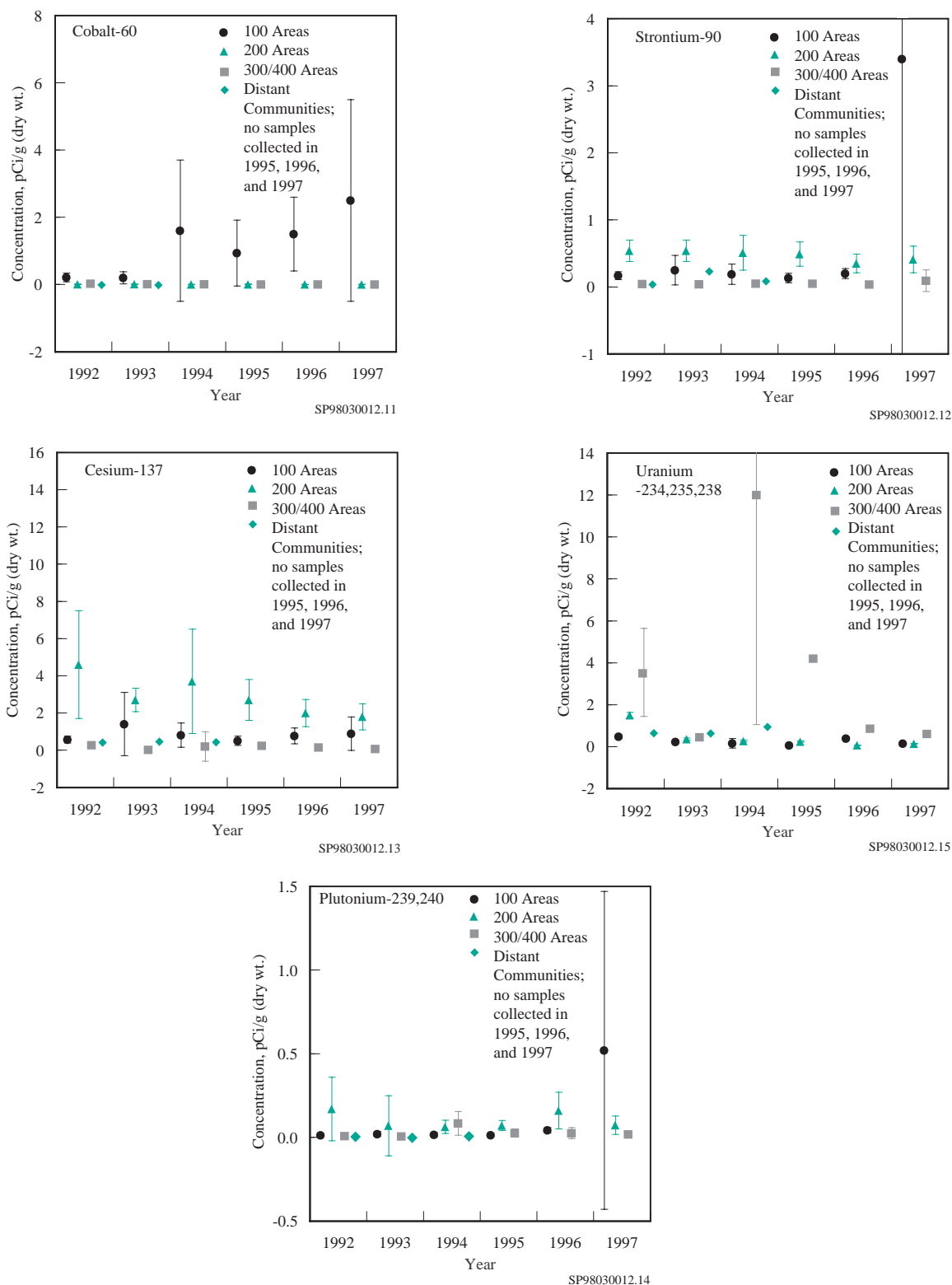
**200 Areas.** Analytical results from soil samples taken in the 200 Areas were on a downward trend for most radionuclides as a result of facility shutdowns, better effluent controls, radioactive decay, and improved waste management practices. However, for cesium-137, the results were greater than offsite measurements and values obtained from the 100 and 300/400 Areas.

**300/400 Areas.** Analytical results from soil samples taken in the 300/400 Areas were compared to results for other operational areas and to those measured offsite. Uranium levels for these areas were higher than those measured from the 100 and 200 Areas and slightly lower than levels measured at the same locations in 1996. Uranium was expected in these samples because it was used during past fuel fabrication operations in the 300 Area.

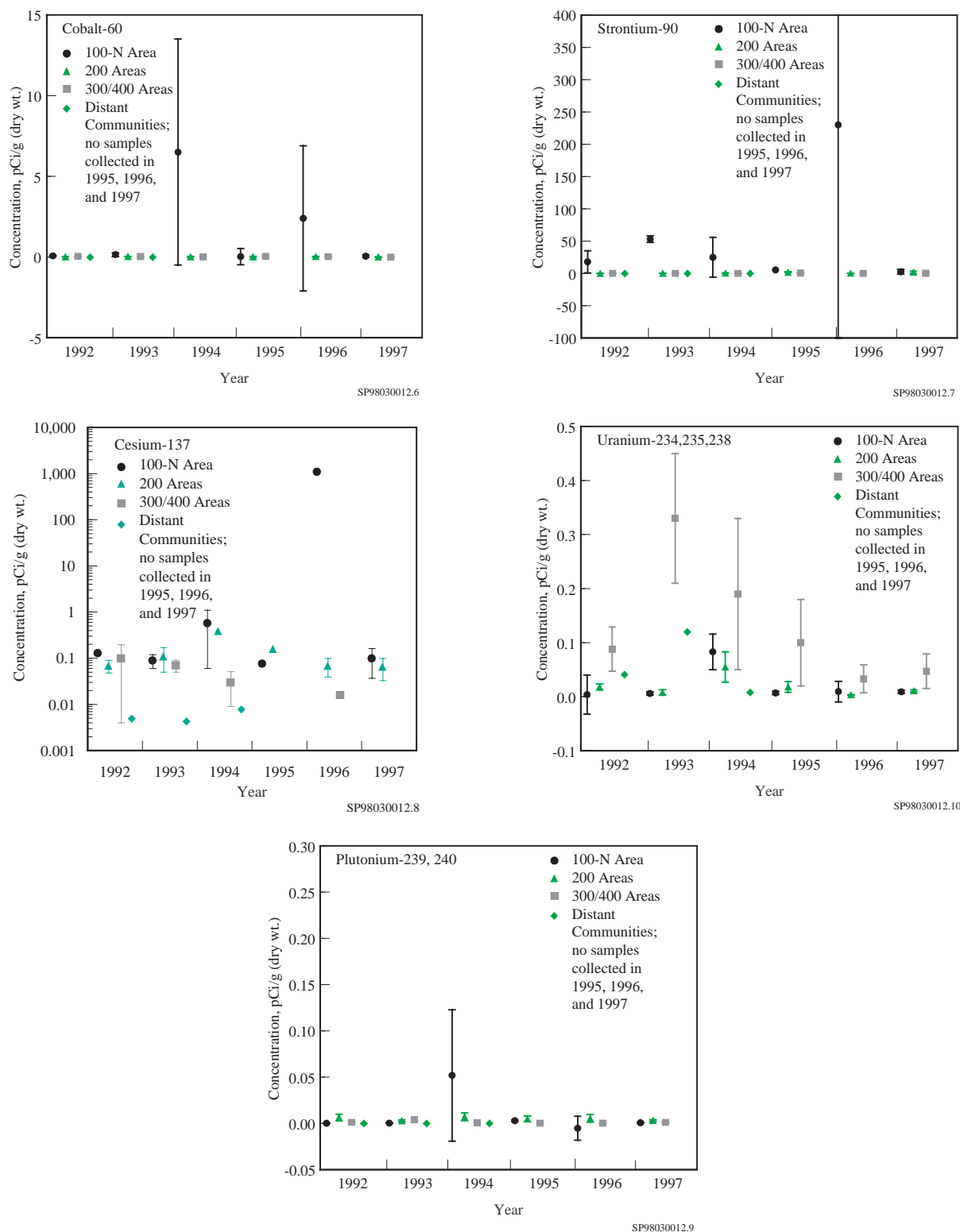
**Radiological Results for Vegetation Samples.** Of the radionuclide analyses performed, cobalt-60, strontium-90, cesium-137, plutonium-239,240, and uranium were consistently detectable. Concentrations of these radionuclides in vegetation were elevated near and within facility boundaries compared to the concentrations measured offsite in 1997. Figure 3.2.3 shows average vegetation values for 1997 and the preceding 5 years. The concentrations show a large degree of variability. In general, concentrations in samples collected on or directly adjacent to the waste disposal facilities were higher than concentrations in samples collected farther away. As with the soil samples, the data show that certain radionuclides were found in higher concentrations in vegetation within different operational areas when compared to concentrations measured in distant communities in 1997. Except for strontium-90 (a fission product) detected in vegetation at the 100-N Area, the predominant radionuclides are generally activation products in the 100 Areas, fission products in the 200 Areas, and uranium in the 300/400 Areas.

**100-N Area.** Analytical results from vegetation samples collected in the 100-N Area in 1997 were comparable to those seen in 1996. The values observed for strontium-90 in samples collected near the N Springs were typically higher than those seen at other locations in the 100-N Area. Generally, 1997 radionuclide levels in 100-N Area vegetation were greater than those measured offsite; levels for cobalt-60, strontium-90, and cesium-137 were higher compared to the concentrations measured in the 200 and 300/400 Areas.

**200 Areas.** Analytical results from vegetation samples taken in 1997 in the 200 Areas were comparable to those seen in 1996. Before 1992, radionuclide levels in these



**Figure 3.2.2.** Average Concentrations ( $\pm 2$  standard error of the mean) of Selected Radionuclides in Near-Facility Soil Samples Compared to Those in Distant Communities, 1992 Through 1997. As a result of figure scale, some uncertainties (error bars) are concealed by point symbols. The 1994, 1995, 1996, and 1997 100 Areas data include the 100-N Area only.



**Figure 3.2.3.** Average Concentrations ( $\pm 2$  standard error of the mean) of Selected Radionuclides in Near-Facility Vegetation Samples Compared to Those in Distant Communities, 1992 Through 1997. As a result of figure scale, some uncertainties (error bars) are concealed by point symbols. The 1994, 1995, 1996, and 1997 100 Areas data include the 100-N Area only. The 1997 cesium-137 data point for the 300/400 Areas is less than zero and cannot be plotted on a log scale.

areas were greater than those measured offsite and were higher for cesium-137 and plutonium-239,240 compared to the 100 and 300/400 Areas. During 1997, the average concentrations for cesium-137 and plutonium-239,240 were similar onsite, offsite, and within the various operational areas.

**300/400 Areas.** Generally, the levels of most radionuclides measured in the 300 Area were greater than those measured offsite, and uranium levels were higher than levels measured in the 100 and 200 Areas. The higher uranium levels were expected because uranium was released during past fuel fabrication operations in the 300 Area. The levels recorded in the 400 Area were at or near those measured offsite.

## 3.2.6 External Radiation

External radiation fields were monitored near facilities and waste handling, storage, and disposal sites to measure, assess, and control the impacts of operations.

### 3.2.6.1 Radiological Field Measurements

Two methods are used for measuring external radiation fields. Hand-held meters are used at individual points of interest to give real-time assessments. Thermoluminescent dosimeters are used at numerous fixed locations to gather dose rate information over longer periods of time. Thermoluminescent dosimeter results can be used individually or averaged to determine dose rates in a given area for a particular sampling period. Specific information about external radiation sampling methods and locations can be found in WMNW-CM-4.

#### Results of Radiological Field Measurements

**Radiation Surveys.** A hand-held micro-rem meter was used to survey points along the 100-N Area springs. Radiation measurements were taken at a height of approximately 1 m (3.28 ft). Prior to 1995, a micro-R meter was used for this survey. This instrument is known to overrespond to low-energy gamma radiation. Since 1995, the micro-rem meter has been used to provide a more accurate measurement of the dose rate. Figure 3.2.4 shows the overall shape of the curve for 1997, which indicates that N Springs shoreline areas with the highest dose rate are, as in the past, juxtapositional with the 1301-N Liquid Waste Disposal Facility.

#### Thermoluminescent Dosimeters

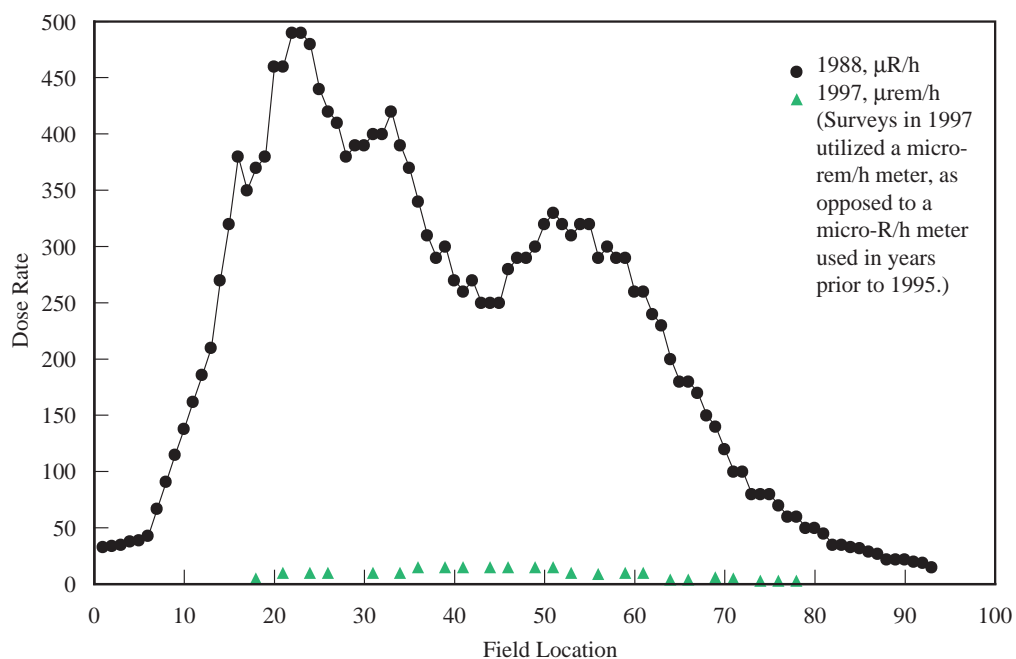
**100-B,C Area.** Four new thermoluminescent dosimeter monitoring sites were established in this area during the fourth quarter of 1997 to evaluate environmental restoration activities at the 116-B-11 and 116-C-1 Liquid Waste Disposal Facilities. Because only 27 days of data were collected at these sites during 1997, the thermoluminescent dosimeter results were extrapolated to 1 year, resulting in an average of 93 mrem/yr, which is comparable to offsite ambient background levels. Table 3.2.9 summarizes the 1997 results.

**100-D,DR Area.** This is the second year that thermoluminescent dosimeters have been placed in this area to evaluate environmental restoration activities at the 116-D-7 and 116-DR-9 Liquid Waste Disposal Facilities. Dose rates measured at these locations were equal to the results of 1996, with an average of 88 mrem/yr, which is comparable to offsite ambient background levels (see Table 3.2.9).

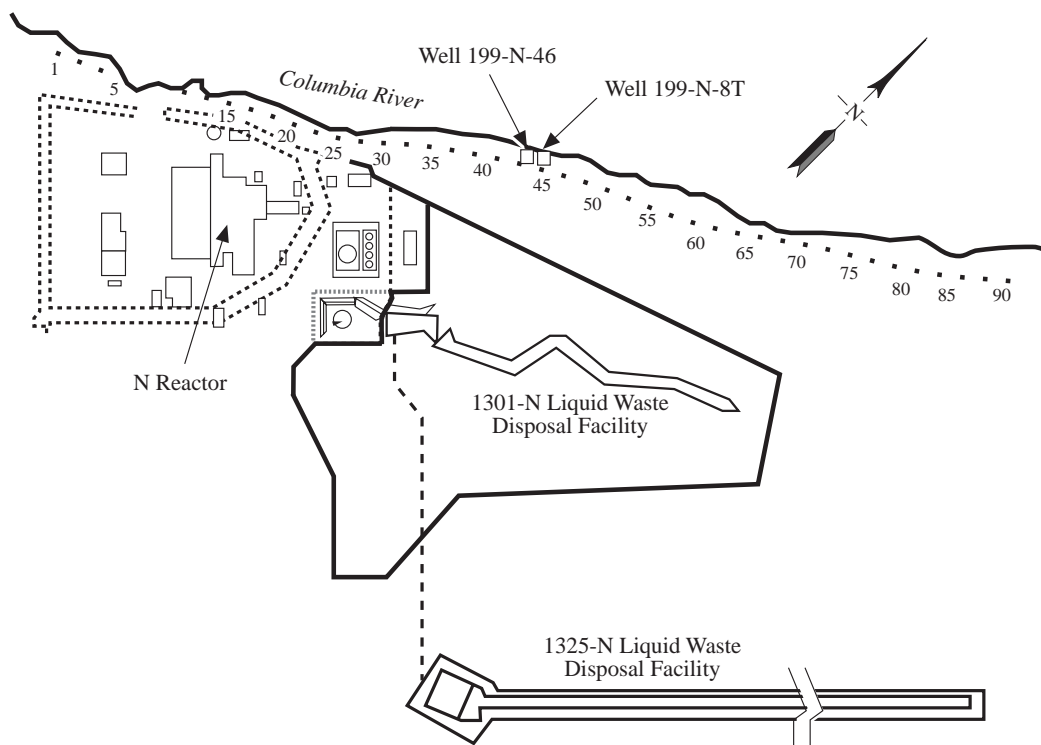
**100-K Area.** This is the fifth year that thermoluminescent dosimeters have been placed in this area, surrounding the K Basins and adjacent reactor buildings. Three of the thermoluminescent dosimeters have, as expected, shown consistently elevated readings (ranging from 3.5 to 30 times greater than the overall 100-K Area average) because of their proximity to radioactive waste storage areas or stored radioactive rail equipment.

**100-N Area.** The 1997 thermoluminescent dosimeter results (see Table 3.2.9) indicate that direct radiation levels are highest near facilities that had contained or received liquid effluent from N Reactor. These facilities primarily include the 1301-N and 1325-N Liquid Waste Disposal Facilities. While the results for these two facilities were noticeably higher than those for other 100-N Area thermoluminescent dosimeter locations, they were approximately 17% lower than dose levels measured at these locations in 1996. Overall, dose rates measured at all locations in the 100-N Area in 1997 were approximately 15% lower than those measured in 1996.

**200/600 Areas.** The highest dose rates were measured near waste handling facilities such as tank farms in the 200 Areas. The highest dose rate was measured at the A Tank Farm in the 200-East Area. The average annual dose rate measured in 1997 (110 mrem/yr) was 8% lower than the 1996 measurement (see Table 3.2.9).



SP98030012.72a



SP98030012.72

**Figure 3.2.4.** Radiation Survey Measurements Along the 100-N Area Shoreline, 1988 and 1997

**Table 3.2.9.** Thermoluminescent Dosimeter Results for Waste Handling Facilities, 1996 and 1997, mrem/yr based on 24 h/d

Area	No. of Locations, 1997	1997		1996		% Change <sup>(a)</sup>
		Maximum	Mean	Maximum	Mean	
100-B,C <sup>(b)</sup>	4	96	93	NA <sup>(c)</sup>	NA	NA
100-D,DR	5	91	88	92	88	0
100-K	11	2,250	470	2,250	480	-2
100-N	22	7,700	1,250	9,200	1,500	-15
200/600	63	350	110	500	120	-8
TWRS <sup>(b,d)</sup>	10	81	78	NA	NA	NA
ERDF <sup>(e)</sup>	3	100	95	100	100	-7
300	8	200	110	240	120	-8
300 TEDF <sup>(f)</sup>	6	87	82	87	85	-4
400	7	88	86	92	83	3

(a) Numbers indicate a decrease (-) or increase from the 1996 mean.

(b) Thermoluminescent dosimeter network was established during the fourth quarter of 1997.

(c) NA = Not applicable.

(d) TWRS = Tank Waste Remediation System Phase I Demonstration Project.

(e) ERDF = Environmental Restoration Disposal Facility.

(f) TEDF = Treated Effluent Disposal Facility.

**Tank Waste Remediation System Phase I Demonstration Project.** Ten new thermoluminescent dosimeter locations were established around the perimeter of this project site during the fourth quarter of 1997 to collect preoperational monitoring data. Because only 67 days of data were collected at this site during 1997, the results were extrapolated to 1 year, resulting in an average of 78 mrem/yr, which is comparable to offsite ambient background levels.

**Environmental Restoration Disposal Facility.** This is the second year that thermoluminescent dosimeters have been placed at this facility to evaluate environmental restoration disposal activities. Dose rates measured were slightly lower than the results of 1996 analyses, with an average of 95 mrem/yr, which is comparable to offsite ambient background levels.

**300 Area/300 Area Treated Effluent Disposal Facility/400 Area.** Table 3.2.9 compares 1997 thermoluminescent dosimeter results to those of 1996 for these areas and facilities. The highest dose rates in the 300 Area were measured near the 340 Waste Handling Facility. The average dose rate measured in the 300 Area in 1997 was 110 mrem/yr, which is a decrease of 8% compared to the average dose rate of 120 mrem/yr measured in 1996.

The average dose rate at the 300 Area Treated Effluent Disposal Facility in 1997 was 82 mrem/yr, which is an decrease of 4% compared to the average dose rate of 85 mrem/yr measured in 1996. The average dose rate measured in the 400 Area in 1997 was 86 mrem/yr, which is an increase of 3% compared to the average dose rate of 83 mrem/yr measured in 1996.

### 3.2.7 Investigative Sampling

Investigative sampling was conducted in the operations areas to confirm the absence or presence of radioactive and/or hazardous contaminants. Investigative sampling took place near facilities such as storage and disposal sites for at least one of the following reasons:

- to follow up radiological surface surveys that had indicated radioactive contamination was present
- to conduct preoperational surveys that quantify the radiological/hazardous conditions at a site before facility construction or operation
- to quantify the radiological condition of a site before remediation

- to determine if biotic intrusion (e.g., animal burrows or deep-rooted vegetation) had created a potential for contaminants to spread
- to determine the integrity of waste containment systems.

The maximum concentrations of radioactive isotopes from samples collected during these investigations are given in Table 3.2.10. Complete results for these investigations, including counting errors, and, where appropriate, field instrument and dose readings, are provided in HNF-EP-0573-6.

Generally, the predominant radionuclides discovered during these efforts were activation products and strontium-90 in the 100 Areas, fission products in the 200 Areas, and uranium in the 300 Area. Hazardous chemicals generally have not been identified above background levels in pre-operational environmental monitoring samples and no special characterization samples were collected in 1997.

### 3.2.7.1 Collection of Investigative Samples and Analytes of Interest

Investigative samples collected in 1997 included sludge, soil, vegetation (e.g., grass, tumbleweeds, rabbitbrush, sagebrush), insects (darkling beetles), reptiles (sagebrush lizards), a bird nest, mammal feces (e.g., mouse, rabbit, coyote), and mammals (e.g., deer mouse, Great Basin pocket mouse, cottontail rabbit). A summary of radioisotopic analyses was presented in Table 3.2.10.

Methods for collecting or otherwise obtaining investigative samples are described in WMNW-CM-4. Field monitoring was conducted to detect radioactivity in samples before they were submitted for analysis. Field monitoring results are expressed as counts per minute (counts/min) when a Geiger-Müller detector is used or as millirad per hour (mrads/h) when an ion chamber is used. Laboratory sample analysis results are generally expressed in picocuries per gram (pCi/g), except for extremely small samples and then in picocuries per sample (pCi/sample). Maximum concentrations, rather than averages, are presented here.

### 3.2.7.2 Radiological Results for Investigative Samples

Investigative samples were collected where known or suspected radioactive contamination was present or to

verify radiological conditions at project sites. In 1997, 30 samples were analyzed for radionuclides, and 27 showed measurable levels of contamination. Another 115 samples were collected during cleanup operations, and were disposed of without isotopic analysis, though field instrument readings were recorded. A detailed data summary of all known radioactive contamination incidents in the operations areas during 1997 is provided in HNF-EP-0573-6.

**Sludge.** In 1997, two samples of dried sludge were collected from the contaminated C-5 Tank in the 200-East Area to determine if the potential for flaking and dispersal by winds might require the surface to be stabilized. The analytical results from these samples showed that all radionuclide concentrations were below regulatory limits (see Table 3.2.10).

**Soil.** In 1997, no investigative soil samples were collected for radioisotopic analysis. There were 51 incidents of contaminated soil or specks found during cleanup operations were disposed of in low-level burial grounds without analysis. External radioactivity ranged from slightly above background (approximately 100 counts/min) to 38 mrads/h. The contaminated areas were posted or cleaned up.

In 1997, the number of contamination incidents, the range of radiation dose levels, and radionuclide concentrations generally were within historical ranges. Areas of special soil sampling that were outside radiological control areas and had radiation levels greater than control limits were posted as contamination areas.

**Vegetation.** In 1997, four tumbleweed samples, one rabbitbrush sample, and one grass sample were analyzed for radionuclide contaminants (see Table 3.2.10). The maximum radionuclide concentrations were in a tumbleweed sample from near the 221-U Building in the 200-West Area and consisted primarily of strontium-90 (250,000 pCi/g) and cesium-137 (1,800,000 pCi/g). The rabbitbrush sample from near T Tank Farm in the 200-West Area contained primarily strontium-90 (1,100 pCi/g) and cesium-137 (310 pCi/g). In addition, 40 instances of contaminated vegetation were recorded in the operational areas in 1997. This vegetation was discovered during remedial operations, surveyed with field instruments, and disposed of in low-level burial grounds. The field instrument readings for the vegetation ranged from approximately 100 to >1,000,000 counts/min). During 1997, the numbers of contaminated vegetation (both samples and those disposed without analysis) exceeded those of the

**Table 3.2.10.** Investigative Samples Collected from Hanford Site Operational Areas, 1997

Sample Type	Collection Area (No. of Samples)	Radionuclides	Maximum Concentration, pCi/g
Dried sludge	200-East Area (2)	$^{60}\text{Co}$	<14,000 <sup>(a)</sup>
		$^{90}\text{Sr}$	<10,000 <sup>(a)</sup>
		$^{137}\text{Cs}$	<15,000 <sup>(a)</sup>
		$^{152}\text{Eu}$	<65,000 <sup>(a)</sup>
		$^{154}\text{Eu}$	<45,000 <sup>(a)</sup>
		$^{155}\text{Eu}$	<36,000 <sup>(a)</sup>
		$^{238}\text{Pu}$	<18,000 <sup>(a)</sup>
		$^{239,240}\text{Pu}$	<18,000 <sup>(a)</sup>
		Total U	190
Grass	200-East Area (1)	$^{60}\text{Co}$	<2.4 <sup>(a)</sup>
		$^{90}\text{Sr}$	1.3
		$^{137}\text{Cs}$	<4.9 <sup>(a)</sup>
		$^{152}\text{Eu}$	<11 <sup>(a)</sup>
		$^{154}\text{Eu}$	<6.1 <sup>(a)</sup>
		$^{155}\text{Eu}$	<8.3 <sup>(a)</sup>
		$^{238}\text{Pu}$	<3.0 <sup>(a)</sup>
		$^{239,240}\text{Pu}$	3.9
		Total U	870
Rabbitbrush	200-West Area (1)	$^{90}\text{Sr}$	1,100
		$^{137}\text{Cs}$	310
Tumbleweeds	200-East Area (2)	$^{90}\text{Sr}$	28
		$^{137}\text{Cs}$	150
Tumbleweeds	200-West Area (2)	$^{90}\text{Sr}$	250,000
		$^{137}\text{Cs}$	1,800,000
Darkling beetle	200-West Area (1)	$^{90}\text{Sr}$	180
Sagebrush lizard	200-East Area (1)	$^{90}\text{Sr}$	68
		$^{137}\text{Cs}$	33
Bird nest	200-West Area (1)	$^{90}\text{Sr}$	29
		$^{137}\text{Cs}$	370
Mouse feces	200-West Area (1)	$^{60}\text{Co}$	28,000
		$^{90}\text{Sr}$	170,000
		$^{137}\text{Cs}$	130,000
		$^{154}\text{Eu}$	26,000
		$^{155}\text{Eu}$	11,000
		$^{238}\text{Pu}$	8,100
		$^{239,240}\text{Pu}$	33,000
		Total U	160,000
Mouse nests	200-East Area (2)	$^{90}\text{Sr}$	9,200
		$^{137}\text{Cs}$	860

**Table 3.2.10.** (contd)

Sample Type	Collection Area (No. of Samples)	Radionuclides	Maximum Concentration, pCi/g
House mouse	200-East Area (1)	<sup>90</sup> Sr <sup>137</sup> Cs	160,000 4,600
Deer mice	200-East Area (3)	<sup>90</sup> Sr <sup>137</sup> Cs	590 1,000
Deer mice	200-West Area (3)	<sup>90</sup> Sr <sup>137</sup> Cs	92,000 12,000
Great Basin pocket mouse	100-N Area (1)	<sup>60</sup> Co <sup>90</sup> Sr <sup>137</sup> Cs	43 150 10
Great Basin pocket mice	200-East Area (2)	<sup>90</sup> Sr <sup>137</sup> Cs	19,000 260
Great Basin pocket mouse	600 Area (1)	<sup>90</sup> Sr <sup>137</sup> Cs	220 17
Cottontail rabbit feces	200-West Area (1)	<sup>90</sup> Sr <sup>137</sup> Cs	4,400 120
Cottontail rabbit	200-East Area (1)	<sup>90</sup> Sr <sup>137</sup> Cs Total U	7,200 2,600 1,200
Cottontail rabbits	200-West Area (2)	<sup>90</sup> Sr <sup>137</sup> Cs	5,000 190
Coyote feces	200-West Area (1)	<sup>90</sup> Sr <sup>137</sup> Cs	45 710

(a) Below analytical detection limits.

previous year by a factor of four. This was primarily because of climatological conditions (i.e., increased frequency and quantity of precipitation), making the vegetation control program on the waste sites considerably less effective and resulting in more tumbleweed growth. The radioactivity levels and range of radionuclide concentrations were all within historical ranges (HNF-EP-0573-6). Historically, the greatest number of contaminated vegetation samples (42) were submitted for analyses in 1978 (WHC-MR-0418) but it is not recorded how many contaminated vegetation samples were disposed of without analysis that year.

**Wildlife.** Wildlife is collected either as part of an integrated pest management program designed to limit the

exposure to animals potentially contaminated with radioactive material or as a result of finding radiologically contaminated wildlife-related material (e.g., feces, nests) during a radioactivity surveillance. Animals were collected directly from, or near, facilities to identify potential problems with preventive measures designed to deter animal intrusion. Radiological surveys were performed after collection to determine whether an animal was radioactively contaminated. If a live animal was found to be free of contamination, it was taken to an area of suitable habitat, still in a controlled area, and released. If an animal was contaminated, a decision was made based on the level of contamination, sampling facility, and frequency of occurrence either to collect the animal as a sample or to dispose of the animal in a low-level burial ground.

In 1997, 22 wildlife and wildlife-related samples were submitted for analysis. All of these samples showed detectable levels of contamination (see Table 3.2.10). This compares to 37 contaminated samples (of 41 collected) that were analyzed in 1996, 22 contaminated samples (of 25 collected) that were analyzed in 1995, and 16 contaminated samples (of 27 collected) in 1994. The numbers of samples submitted depended on opportunity (i.e., resulting from the pest control activities at facilities) rather than exact numbers submitted from established sampling points. The maximum radionuclide concentrations in 1997 were all in mouse feces collected along railroad tracks east of 218-W-4B Burial Ground in the 200-West Area. The concentrations included cobalt-60 (28,000 pCi/g); strontium-90 (170,000 pCi/g); cesium-137 (130,000 pCi/g); europium-154 (26,000 pCi/g); europium-155 (11,000 pCi/g); plutonium-238 (8,100 pCi/g); plutonium-239,240 (33,000 pCi/g); and total uranium (160,000 pCi/g). A sample of three house mice from the 244-AR Vault in the 200-East Area had 160,000 pCi/g of strontium-90.

Contaminated animal samples, which were somewhat atypical for the special sample program, included darkling beetles with elevated strontium-90 levels (180 pCi/g) found inside the 272-S Building in the 200-West Area, and a sample of 12 sagebrush lizards containing low levels of strontium-90 (68 pCi/g) and cesium-137 (33 pCi/g) found in a contaminated cabinet outside the Plutonium-Uranium Extraction Plant in the 200-East Area (see Table 3.2.10).

Additionally, there were 8 cases of contaminated wildlife or related samples (e.g., nests, feces) found during cleanup operations that were not analyzed. The numbers of animals found to be contaminated with radioactive material, the radiation levels, and the range of radionuclide concentrations were within historical ranges (WHC-MR-0418).